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ABSTRACT

The purpose of several studies was to examine the effects that differentially coded (black and white or color) illustrations had on students who were classified as field independent, field neutral, and field dependent on tests measuring different educational objectives. The effects of visual and verbal test formats were also examined. In general, results reveal an insignificant interaction between coding type and level of field dependence. However, field dependency was found to be an important instructional variable, and, for some types of learning objectives, the process of color coding instructional materials may reduce achievement differences attributed to differences in cognitive style. Unexpectedly, students who received verbal tests across all field dependence levels achieved significantly higher mean scores than did those who received the visual test formats. (Author/MES)

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A Review of Color Coding and Field Dependence Research

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ED 436 131

Abstract

The purpose of several studies was to examine the effects that differentially coded (black and white and color) illustrations had on students who were classified as field independent, field neutral and field dependent on tests measuring different educational objectives. The effects of visual and verbal formats were also examined. In general, results reveal an insignificant interaction between coding type and level of field dependence. However, field dependency was found to be an important instructional variable, and that for some types of learning objectives the process of color coding instructional materials may reduce achievement differences attributed to differences in cognitive style. Unexpectedly, students who received verbal tests across all field dependence levels achieved significant higher mean scores than did those who received the visual test formats.

With the response capabilities inherent in the new electronic technologies, educators are becoming increasingly interested in examining instructional effects of the learners' cognitive learning style. Cognitive learning style is generally considered to describe the manner in which an individual interacts with and processes information. Probably the most extensively researched cognitive style which has the widest application to educational problems is known as field dependence/independence (Witkin, Dyk, Faterson, Goodenough, & Karp, 1962). The field dependence/independence continuum, as it applies to learners, describes the degree to which learners will interact with a visual presentation, that is, whether the learner will merely interact with the visual as presented or will he/she analyze, reorganize and synthesize the instructional field to make the content more meaningful and memorable (Ausburn, & Ausburn, 1978). Field dependent individuals, when presented a visualized presentation tend to modify the structure but accept and interact with it as it is presented. They tend to fuse all segments within the visual field and do not view or interact with the visual components discretely. Field independents tend to act upon a visual stimulus, analyzing it when it is organized and providing their own structure when it lacks organization. The findings of most studies in the literature examining achievement indicate a superiority of FID students over FD student in terms of performance (Moore, 1985; Reardon, & Moore, 1988; Canelos, Taylor, & Gates, 1980; Witkin, Moore, Goodenough, & Cox, 1977). These results are explained by the fact that FID student utilize their competence in articulation or in analyses and structuring (Couch, & Moore, 1992).

Although many studies have examined the effects of visual attributes on learning (Dwyer, 1978; Dwyer, 1987) few have studied the effects of varied visual attributes on specific cognitive learning styles. Research has shown that color coding helps learners organize or categorize information into useful patterns which enables them to interpret and adjust more readily to their environment. It was hypothesized that color-coded visuals would be more effective than black and white-coded visuals in enhancing the solvent visual cues, thereby making them more identifiable and instructional to field dependent learners. The color coding would attempt to compensate for the restructuring skills absent in the field dependent learners and subsequently lead to deeper information processing and increased achievement. This hypothesis seemed plausible since field dependent learners tend to be global in perception and would be most inclined to take advantage of the increased structure provided by the color coding.

Previous research (Dwyer, 1978; Dwyer, 1987; Dwyer, 1968) has verified the superiority of color coded visuals over black and white illustrations in answering questions of a verbal nature, i.e., terminology and comprehension (Dwyer, 1978; Dwyer, 1987). However, there was no research available which investigated the role of color on verbal or visual type questions across the cognitive style known as field dependence/independence (FD/I). Additionally, it was not known whether coding (B&W and Color) and field dependence interact or whether color coding positively affects the deficiency of field dependent learners to organize and structure instructional content.

Statement of the Problem

Specifically, the purpose of these studies was to examine the effect that coding (B&W and color) has on the achievement of students categorized as FD/I learners and to determine if there was an interaction between field dependency and color across both visual and verbal oriented tests measuring different educational objectives.

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Instructional Treatments

The subject content for the studies consisted of a 2,000 word instructional booklet on the anatomy and functions of the human heart. Each booklet contained nineteen illustrations which were designed to illustrate the content being presented verbally. Booklets received by the students in the black and white and color coded treatments were identical in verbal and visual content with the exception of the color code which was applied to one treatment.

The instructional material consisted of a 7" by 8-1/2" spiral bound booklet. The booklet included one page of directions and twenty pages of concepts and functions on the heart integrated by prose text with accompanying visualization. A simple line drawing was positioned (2-3/4" by 3-1/8") on each frame. All booklet pages were clearly numbered, with the prose text in the lower half of each page and the visualization in the upper half of the page. The arrows were employed to focus learner attention on relevant information in the visual.

Directions on the first page of the booklet indicated to the learner that the materials were part of an investigation to study the relative effectiveness of visual illustrations which accompanied printed instruction. Learners were directed to be attentive to both the written and visual information. They were further instructed that there was no time limit to the instructional sequence, and that a test with several parts would be administered when they felt they had mastered the presented concepts.

Given all of the above design elements found within the black/white instructional booklets, the color coded treatment differed only in the application of color to certain verbal and visual concepts illustrates the color coding application. Six color categories and black were used to code the heart concepts.

To facilitate replication printer's ink colors selected were from the Pantone Matching System, developed by Pantone Incorporated. The six colors were: red (Pantone--warm red), blue (Pantone--process blue), green (Pantone--green), purple (Pantone--No.227), brown (Pantone--No.471), and gold (Pantone--No.124). The black (Pantone--black) was used for all the non-color coded design elements within the color coded material and for all the design elements within the black/white material. The illustrations in the black and white version contained black and white coded line drawings which highlighted the information and process being presented. Students receiving the color coded treatment received the same visuals as did students receiving the black and white treatment; however, several different colors were used to highlight the information being discussed. The major independent variables in the studies were the effect that B&W and Color Coding of information had on the information processing strategies of students identified as processing different levels of field dependence (FI, FN, FD).

Criterion Measures

Each student in each treatment received the Group Embedded Figures Test (GEFT) (Witkin, Oltman, Raskin, & Karp, 1971). The GEFT (11) is a group-administered, 25 item test administered in three timed sections (2,2 and 5 minutes each). Students must trace one of eight simple figures embedded in figures of greater complexity. Reported reliability is .82. Students participating in these studies were classified as field independent (FI), field neutral (FN) in field dependent (FD) based on their performance on the GEFT. The grand mean and standard deviations was calculated for each study. Students achieving one-half standard deviation above the grand mean were considered to be FI while students achieving one-half standard below the mean were considered to be FD. Field neutral students were those achieving one-half standard deviation on either side of the mean.

After receiving their respective coded treatments each student then received a battery of individual tests in either a verbal or visual format. These tests were designed to measure achievement of different types of educational objectives. The following description of the criterion tests, adapted from Dwyer (1978, pp.45-47) illustrated the types of instructional objectives assessed in this study.

Drawing Test

The objective of the drawing test was to evaluate student ability to construct and/or reproduce items in their appropriate context. The drawing test provided the students with a numbered list of terms corresponding to the parts of the heart discussed in the instructional presentation. The students were required to draw a representative diagram of the heart and place the numbers of the listed parts in their respective positions. For this test the emphasis was on the correct positioning of the verbal symbols with respect to one another and in respect to their concrete referents.

Identification Test

The objective of the identification test was to evaluate student ability to identify parts or positions of an object. This multiple-choice test required students to identify the numbered parts on a detailed drawing of a heart. Each part of the heart which had been discussed in the presentation was numbered on a drawing. The objective of this test was to measure the ability of the student to use visual cues to discriminate one structure of the heart from another and to associate specific parts of the heart with their proper names.

Terminology Test. This test consisted of items designed to measure knowledge of specific facts, terms, and definitions. The objectives measured by this type of test are appropriate to all content areas which have an understanding of the basic elements as a prerequisite to the learning of concepts, rules, and principles.

Comprehension Test. Given the location of certain parts of the heart at a particular moment of its functioning, the student was asked to determine the position of other specified parts or positions of other specified parts of the heart at the same time. This test required that the students have a thorough understanding of the heart, its parts, its internal functioning, and the simultaneous processes occurring during the systolic and diastolic phases. The comprehension test was designed to measure a type of understanding in which the individual can use the information being received to explain some other phenomenon.

Total Test Score. The items contained in the individual criterion tests were combined into a composite test score. The purpose was to measure total achievement of the objectives presented in the instructional unit.

The design of the visual form of each of the criterion tests utilized only one drawing with four or five letter labels in all items in which it was possible to do so while maintaining clarity and correspondence to the verbal test items. However, two items in the terminology test and all items in the comprehension test required four drawings. The item stems of both the verbal and visual test questions were verbal and asked the same question. In addition, the visual distracters in the visual tests corresponded to the verbal distracters in the verbal tests as closely as was reasonable. The description of the verbal tests given previously also describes the visual tests.

Summaries of Studies Investigating Color Coding and Cognitive Style

Study 1. Moore, D.M. & Dwyer, F.M. (1991). Effect of color coded information on students' level of field dependence. Perceptual and Motor Skills. 72, 611-616.

Number of subjects: N=119

Independent variables: black and white and color coded treatments; levels of field dependence (FI/FN/FD).

Dependent variables: terminology, comprehension and total test (combined terminology and comprehension).

Number of Students in each level of field dependence: FI=43, FN=45, FD=29.

Results: Insignificant interaction between coding strategy, (black and white and color coded) and levels of field dependence (FI, FN, FD).

Field independent students achieved significantly higher mean scores on both the terminology and comprehension tests when receiving the black and white coded treatments; however, when color coded treatments were used insignificant differences in achievement resulted between the FI and FD students.

On the terminology and comprehension tests insignificant differences in mean achievement resulted between students receiving the black and white and color coded treatments.

Study 2 Dwyer, F.M. & Moore, D.M. (1991). Effect of Color Coding on visually amended tests with students of different cognitive styles. The Journal of Psychology, 125, 677-680.

Number of subjects: N=117

Independent variables: black and white and color coded treatments; levels of field dependence (FI, FN, FD).

Dependent variables: scores on the two visual oriented tests--drawing and identification. Total test was a combination of both criterion measures.

Number of Students in each level of field dependence: FI=43, FN=29, FD=45.

Results: Across all levels of cognitive (FI, FN, FD) significant differences were found to exist for cognitive style and color coding on the drawing, identification and total tests. Students at all levels who received the color coded treatment achieved significantly higher scores than did students who received the black and white color coded treatments.

On the drawing test FI students scored significantly higher than did FD students on both the black and white and color coded treatments. On the identification test achievement differences between students receiving the black and white and color coded treatments were insignificant.

Study 3 Dwyer, F.M. & Moore, D.M. (1991-92). Effect of color coding on visually and verbally oriented tests with students of different field independence levels. Journal of Educational Technology Systems, 20, 311-20.

Number of subjects: N=119

Independent variables: black and white and color coded treatments, level of field dependence (FI, FN, FD).

Dependent variables: achievement scores on the drawing, identification, terminology, comprehension and total criterion test (combination of the instructional criterion measures.

Number of Students in each level of field dependence: FI=43,FN=45,FD=29.

Results: An insignificant interaction was found to exist between coding strategy and levels of field dependence. On all criterion measures for all levels of field dependence, students who received the color coded treatments achieved significantly higher scores than did students receiving the black and white coded treatment.

In analyzing individual performance on the drawing, identification and total criterion test, students receiving the color coded treatments achieved significantly higher mean scores than did students receiving the black and white coded treatments. However, on the terminology and comprehension tests there were insignificant differences in achievement between students receiving the black and white and color coded treatments.

Significant differences existed in favor of FI students on all criterion measures when they received the black and white coded treatments; however, when students received the color coded treatments insignificant differences were found to exist on the four individual criterion measures.

Study 4 Moore, D.M. & Dwyer, F.M. (1994). Effect of cognitive style in test type (visual or verbal) and color coding. Perceptual and Motor Skills, 79, 1532-1534.

Number of subjects: N=183

Independent variables: black and white and color coded treatments; levels of field dependence(FI, FN, FD), visual and verbal test formats.

Dependent variables: scores on both the verbal and visual test formats for the terminology, identification, drawing comprehension and total criterion measures.

Number of Students in each level of field dependence: FI=66, FN=74, FD=43.

Results: On all criterion measures significant achievement differences occurred in favor of FI students on color coding in favor of color coding. Students receiving the verbal test formats achieved significantly higher achievement scores on all criterion measures than did students receiving the visual test formats.

Results and Discussion

The results of these experimental studies support the contention that field independent and field dependent learners differ in the cognitive processes they use as in the effectiveness of these cognitive processes as measured on

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tests measuring different educational objectives. The studies found that across all studies where FI and FD students reviewed black and white coded treatments, the field independent students scored significantly higher than did field dependent students on the terminology/drawing, terminology/comprehension and total criterion tests. These results support prior research (Moore, & Bedient, 1986) which found that independent learners tend to score higher on criterion measures which require the acquisition of information from visualized instruction and are used to assessing visually complemented instruction. This finding is also consistent with the previous reviews of the literature that have concluded that field independent learners exhibit an active, hypothesis testing strategy toward learning, whereas field dependent learners tend to employ a more tentative or spectator approval to learning (Witkin, Moore, Goodenough, & Cox, 1977). The results also indicated that across all studies on a number of criterion measures (e.g., drawing and identification tests) the use of color coding of visualization did not provide sufficient structuring of the critical information to alter the information processing level of field dependent learners.

It was expected that the color coded treatments would make the relevant cues more explicit to the field dependent learners, thereby improving their performance. When both FI and FD students both received the color coded treatments insignificant differences in mean achievement on all four individual criterion measures. Apparently, the color coded illustrations provided a sufficient structure for the FD learners to interact with and internalize at levels similar to that achieved by the FI learners. Another possible explanation may be presented to explain these results. Witkin, Moore, Goodenough, and Cox (1977). have indicated that it is possible to induce FD learners to use analytical techniques by providing specific directions as to how to proceed. Possibly the specific directions on the first page of the instructional treatments was sufficiently strong to instigate greater levels of information processing thereby enabling them to achieve at levels realized by the FD learners. Annis' study (1979) investigating cognitive style on study technique found that field dependent students did not score as well as field independent students in completing items of high structural importance even when the passage was well organized. The implication being that the field dependent students, in addition to receiving the well organized instructional module received specific directions alerting them to the fact that would be tested upon completion of the module. The combination of specific directions and the color coded illustrations enabled the field dependent students to achieve levels similar to those achieved by the field independent students.

It was hypothesized that the students who received the visual version of the criterion measures would achieve significant higher scores in the criterion measures. This was not the case, in fact, students who received the verbal version of the criterion measures achieved significantly higher scores than did students who received the visual versions. These results were unexpected and require further study before definitive conclusions can be proposed.

Note: Presentation based upon an article entitled: Dwyer, F.M., & Moore, D.M. (1997-1998). Field dependence and color coding: A review and summary of research evidence. Journal of Educational Technology Systems. 26 (3), 243-253.

References

Annis, L.F. (1979). Effect of cognitive style and learning passage organization on study technique effectiveness. Journal of Educational Psychology, 71, 620-626.

Ausburn, L.V., & Ausburn, F.B. (1978). Cognitive styles: Some information and implications for instructional design. Educational Communications and Technology Journal, 26, 336-354.

Canelos, J.J., Taylor, W.D., & Gates, R.B. (1980). The effects of three levels of visualization stimulus complexity on the information processing of field dependents and field independents when acquiring instructional objectives. Journal of Instructional Psychology, 7, 65-70.

Couch, R.A., & Moore, D.M. (1992). The effects of imagery rehearsal strategy and cognitive style on the learning of different levels of instruction. International Journal of Instructional Media, 19, 53-63.

Dwyer, F.M. (1968) Effect of varying the amount of realistic detail in visual illustrations designed to complement programmed instruction. Perceptual and Motor Skills, 27, 351-354.

Dwyer, F.M. (1987). Enhancing visualized instruction: recommendations for the practitioner. Learning Services, State College, Pennsylvania.

Dwyer, F.M. (1978). Strategies for Improving Visual Learning, Learning Services, State College, Pennsylvania.

Moore, D.M. (1985). Cognitive styles, presentation made in a visual location task. International Journal of Instructional Media, 12, 179-184.

Moore, D.M., & Bedient, D. (1986). Effects of presentation mode and visual characteristics on cognitive style. Journal of Instructional Psychology, 13, 19-24.

Reardon, L.B., & Moore, D.M. (1988). The effect of organization strategy and cognitive styles on learning from complex instructional visuals. International Journal of Instructional Media, 15, 353-363.

Witkin, H. A., Oltman, P. K., Raskin, E., & Karp. (1971). A Manual for the Group Embedded Figures Test. Consulting Psychologists Press, Inc. Polo Alto, California.

Witkin, H.A., Dyk, R.B., Faterson, H.F., Goodenough, D.R., & Karp, S.A. (1962). Psychological differentiation. Potomac, Md.: Erlbaum, 1974.

Witkin, H.A., Moore, C. A., Goodenough, D.R., & Cox, P.W. (1977). Field Dependent and Field Independent Cognitive Styles and their Implications. Review of Educational Research, Winter 1977, 47, 1-64.